

Dialogues From Texts: How to Generate Answers from a Discourse Model

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1. Introduction

In this paper, we shall deal with a system for text generation and understanding called GETA_RUN (GEneration of Text and Analysis for Reference Understanding). Dialogues in our system may be regarded as a sequence of question-answering actions with the aim to retrieve as much information as possible from a text. In a certain sense the system acts as a very intelligent information retrieval system which allows to recover the contents of a text on the basis of what is actually being linguistically expressed. No implicit information is recoverable from the system, however.

The system works by encoding the linguistic contents of a text fully analyzed in the Discourse Model where all entities, properties and relations are recorded. Further semantic properties and relations are then transferred into a Knowledge Representation Module running under KL-One to be used for consistency check whenever the dialogue is started up.

The system is capable of building a discourse plan in order to keep track of the ongoing conversation and then to specify semantic structure sufficient for sentence level generation.

What linguistic information constitutes an adequate input to the tactical component ? In order to answer this first question we need to decide how much work has to be assigned to the planner. From the subdivision of labour between the two components, we shall be able to ascertain what is left to the grammar itself and the lexicon.

2. Plan Creation from Rhetorical Relations and Conceptual Representations

There are two main problems we are faced with when thinking of answers/descriptions generator: choice of actual words, and order in which they should occur. In order to select the appropriate lexical predicate, a number of crossing abstract representation should conspire to produce the most adequate result. In particular, we assume that in a plan there are different levels of abstractions involved: the higher level is represented by relations very similar to RST rhetorical relations. These in turn specialize into tuples of semantic relations which are subsequently used to recover predicates from the lexicon. These tuples may be represented by a semantic class and an associated aspectual class, as for instance in:

narrative(movement, activity).

background(existence, state).

In addition, we need some criteria to establish the order with which events may take place in the world: this is not to be intended in the sense of domain discourse plans for task oriented dialogues above. The idea we have in mind is based on conceptual classes onto which linking rules may be established so as to disallow unwanted sequences, as for instance in,

LR1: $*(GO(TOx) ==> GO(TOx))$

LR2: $*(STAY(ATx) ==> STAY(ATx))$

LR3: $*(BE(ATx) ==> BE(ATx))$

LR4: $*(BE(ATx) ==> GO(TOx))$

These rules are axioms made up of two sides: the left is a part of a conceptual representation and is the consequent and the right side is the premise; they can be applied at sequences of relations one of which must be the unrealized or yet to be realized relation, represented by the left template. The right side template can be linked to any of the relations already present in the plan. The variable "x" is linked to the object, location or other semantic type for an argument. In

particular, in the case of LR4, if some entity has got to be AT(x), he should GO(TOx) first.

Conceptual Representations(CR) have been introduced by Jackendoff and others, however we refer to Dorr(1993) who introduced a number of augmentation to the original set which we also endorse. Delmonte(1990, 1996) considered CR the link from the semantics to the knowledge of the world needed to represent meaning in a general and uniform manner.

Since we endorse LFG as our theoretical framework (Bresnan, 1987), and our lexical forms encompass semantic information related to semantic roles, we assume that the correct mapping from lexical forms and CR is achieved by means of semantic roles and aspectual class. In this way, CRs map onto and outwards Lexical Forms. C-structure and f-structure representation would be completely lost in our framework once the Discourse Model is being built. The Discourse Model only contains reference to semantic roles and other semantic relations like Poss, which have a correspondence in the CR.

As to Aspectual Classes we use them to define lexical classes rather than sentence level aspectual class, which as we said above, is the result of the interaction of an extended number of linguistic elements. Lexical aspect is used to individuate the appropriate internal constituency of the event (see also Delmonte, 1997 and above), and also to drive the semantics, which together with the information coming from arguments and adjuncts will be able to trigger the adequate knowledge representation. In particular, as shown in Passonneau 1988, we need to process referenceto entities and events in the discourse model, in order to know what predicates are asserted to hold over what entities and when. We use the following lexical aspectual classes:

a. achievement; b. achievement irreversible; c. achievement iterable; d. accomplishment; e. accomplishment ingressive; f. activity; g. state; h. state_result

Meaning associated to each semantic class are expanded into conceptual classes by means of aspectual information. For instance, the following class

11 = exten (GO(TO[end] - (GO(TO[exist] finire, creare

is split into the following two meanings:

Funct(exten, achievement irreversible)

CAUSE(GO(TO[end] finire "to end"

Funct(exten, accomplishment)

CAUSE(GO(TO[exist] creare "to create"

where Funct may assume only those rhetorical or discourse relation labels that constitute a conceptually admissible link. Elaboration or Description are not allowed by Linking Rules. Narration and Egression would be allowed.

In the knowledge representation we establish a semantic relation that holds between a sentence and an interval in the spirit of interval semantics. We specify what property of an interval is entailed by the input sentence and then compositionally we construct a representation of the event from the intervals and their associated properties. We already presented in a previous paper the interaction between KL-One and the semantic representation of a story contained in a Discourse Model (see Bianchi, Delmonte, 1997). We shall now concentrate on the Realization or Tactical Component.

3. Extracting-expressing relevant facts from the DM

If we want to characterize the input to the Tactical Component we can paraphrase its contribution as follows:

Select the most relevant sequence of relations for the most important entity of the discourse model and order them temporally; then establish coordinate or subordinate dependancies among adjacent relations. Finally recover arguments for each relation.

However there are two main problems that require particular attention, and they are, choice of cue words and choice of syntactic structure which in turn is cast into another important task, concept aggregation(Hovy, 1994:366). In other words, we have a set of discourse structure that we need to express more concisely: we need to know how (which syntactic structure to use) and what cue word to use. In order to do this, we need to aggregate concepts which are semantically related.

The Focus mechanism allows the Tactical Component to inspect a set of discourse structures to see whether they contain the same focus value; in addition there is a number of additional issues to be taken into account, such as the complexity of the remainder of the discourse substructure, the overall style of the text and its rhythm. In more detail, Hovy suggests a number of heuristics to govern sentence formation, including:

- Embedding of background information can be realized as an adjective, appositive NP, PP or relative clause in this order of preference;
- Sentences should contain at most one level of embedding which should occur before focus transformation, and in the leftmost nuclear clause with the same focus value;
- Coordination occurs only between clauses headed by the adequate rhetorical relation such as JOIN, SEQUENCE, CONTRAST;
- Sentences should contain no more than three clauses.

We are now able to pick up the relevant fact and its semantic structure from the Discourse Model. We extract the relation and its arguments from the list of facts associated to the current first entity. In particular we are interested in highlighting the semantic role of the main entity in the current fact. This will be used to decide whether the Voice to be associated to the generating phase has to be set in the Active or in the Passive mode.

Other important semantic relations and properties to be kept under control are:

- lexical level semantic properties of predicates like: checking for synonyms and antonyms
- lexical level semantic relations between properties, events and entities which can be the lexicalization of the same meaning or be ambiguous. Other important semantic relations are semantic inclusion and overlapping in meaning which may turn the use of a given lexical item redundant;
- utterance level semantic relations: may have the same properties above and in addition a certain utterance may express meaning which strictly implicates and/or presupposes the meaning of a previously expressed utterance, thus making its content redundant;
- an utterance may be contradictory and/or deny the meaning of a previous utterance; contradiction may be detected at the level of temporal reasoning when the order of occurrence of two adjacent event has to be that of precedence rather than consequence.
- finally the way in which entities are expressed may vary from proper noun to empty pronominal, depending on the previous text; also properties may be expressed in a propositional way, as an adverbial phrase or as an adjectival phrase.

4. Tactical Component

It is generally agreed that a suitable input to the realization component must be constituted by some form of semantic representation which may include the actual lexical choice or some abstract conceptual representation of each lexical item for the final realization.

However, there are many differences that can be found between the approaches documented in the literature and ours. In our system, input to the realization has a general argument structure and a number of functional features associated that are used by the grammar to generate the most adequate structural configuration. Top-down semantic, rhetoric and pragmatic decisions are paired with bottom-up lexical requirements imposed by each predicate on the fly, while realizing each lexical item. In particular, argument specification only reflects the order each

argument has in canonical predicate argument structure. Syntactic non-canonical realizations, like for instance passive construction, expletive subject insertion, left-dislocation and any other possible grammatically relevant structural decision is left to the phrase structure rule component of the grammar. Consider the need to realize one argument as clitic pronoun, as is required in Romance languages: the semantic structure would carry the information that the second argument of the predicate belongs to TOP type, as for instance in the following representation for Mario, which is realized as the clitic pronoun “lo”/him independently by the grammar. The fact that Mario has been assigned the TOP type in the slot reserved for Definiteness does not depend on syntactic but merely on pragmatic and semantic information. Features for the choice of the adequate pronominal form are partially extracted from the lexical entry associated to Mario, which are Person=3, Gender=Masculine, Animacy= Human,

[top, nil, sing, mario] --> lo

In addition, Number is set to singular, and Case is equal to Accusative owing to the fact that the argument is the second. The additional information that “lo” should be anteposed to the verbal predicate is not encoded in the semantic structure but is independently imposed by the phrase structure rules associated to the “transitive verb” syntactic class, and the presence of a TOP argument. On the contrary, by interleaving focus rules with the realization grammar, have the undesirable side-effect of having to check where the Focus argument has been assigned in the case frame slots of the sentence level predicate before entering the correct vp rule. In our grammar, we capture passive structures very simply by means of the feature PASSIVE in slot assigned to VOICE in the input semantic structure. The grammar will look for second argument or third argument according to argument structure and execute a Lexical Redundancy Rule, according to LFG: the argument selected will be set to Subject of the current structural realization and realized first. Then second argument will be passed to VP structure as Adjunct Oblique with the semantic role of Agent. Semantic role will trigger the adequate preposition “by” to be instantiated in front of the NP. Choice of focussed constituent is again present in the linear disposition of arguments: in case Recipient/Beneficiary/Goal should be fronted, it would have been positioned as second argument, for ditransitive verbs only, however. In other words, we perform dative shift in the pragmatic/semantic component before entering the realization phase.

4.1 Text Generation in Italian

Generating text in Italian is intrinsically bound to the peculiarities of its surface grammar. Summarizing is a task that requires full discourse structure information which in our case is made available from Geta_run and feeds directly the planning component. In turn, grammar and lexicon needed for the tactical component is readily available from the DCG parser.

Italian is a language which allows and in some cases requires the Subject to be generated in postverbal position. Subject inversion is a free process, i.e. it does not obey such constraints as the D(efiniteness) E(effect), and requires no expletive, as is the case with other languages like English, German or French. In fact, Italian is regarded as a language with empty expletives. Choice for auxiliaries is determined on the basis of syntactic category: unaccusatives require “be”, while the other categories require “have”. However, passive and impersonal constructions also require “be” as auxiliary. In addition, Object NP can be expressed as clitic and be thus obligatorily positioned in front of tensed verb.

Here are some examples, where we include verbal features in brackets, a literal translation and finally an approximate English rendering:

1. Arriva [Arriva_3/pers/sing_pres/ind]
lit. Arrives |He is arriving|
2. Arriva Gino [Arriva_3/pers/sing_pres/ind Gino] lit. Arrives John |John is arriving|
3. E' arrivata Maria
[E'_3/pers/sing_pres/ind arrivata_3/pers/sing/fem_past/partic Maria]
lit. Is arrived Mary |Mary has arrived|
4. Gino l'ha conosciuta ieri
[Gino l'_acc ha_3/pers/sing_pres/ind conosciuta_3/pers/sing/fem_past/partic ieri]
lit. John her has known yesterday |John met her yesterday|
5. Cosa hanno detto i tuoi amici?
[Cosa hanno_3/pers/plur_pres/ind detto_3/pers/sing/mas_past/partic i_mas/plur tuoi_2/pers/plur/mas amici_plur/mas]
lit. What have said the your friends |What did your friends say|
6. Gino ha visto ieri Maria sull'autobus
[Gino ha_3/pers/sing_pres/ind visto_3/pers/sing/mas_past/partic ieri Maria sull'autobus_mas]
lit. John has seen yesterday Mary on the bus |Yesterday John saw Mary on the bus |

As can be noticed from the features associated to the verbal morphemes, agreement on the past participle should include Gender as well as Number which in case of unaccusatives should agree with the Subject. However, as example 4 shows, agreement goes with the Object with

transitive verbs. Also notice the apostrophe which deletes the final vowel of clitic pronouns: in this case no information is available on the gender, only case can be inferred.

Example 5 is a case of obligatory postverbal Subject: “Cosa i tuoi amici hanno detto” is ungrammatical. Notice the use of the article in front of a possessive pronoun which is again obligatory and can be dispensed with in case of names denoting family relations like brother, sister, mother etc.

Finally, example 6 shows two important features of Italian and other Romance languages: first, adjuncts can be freely interspersed between Subject and verb or verb and Object, in other words there is no adjacency constraint applicable. Second, Italian has compound prepositions, i.e. a preposition with article which in turn can undergo epenthesis by the use of the apostrophe. In the latter case, generation of the compound preposition requires gender and number information to be made available beforehand, or else it should be generated afterwards.

Input to our Tactical Component is as follows:

Voice: active/passive

Tense: any tense

Mood: any mood including imperative, interrogative etc.

Modality: any modality

Main Relation: the main clause relation

Main Relation:Modification

Adverbial Phrase ; Subordinate Clause ;
Coordinate Clause ; Prepositional Phrase ;
Predicative Adjunct

List of Arguments:

1st Argument: Subject argument - Sentential subject; *2nd Argument:* Object, Oblique, Sentential Object; *3rd Argument:* IndirectObject or Oblique

Argument specifications 1.

Semantic Type:

- a. prop (proper name), b. def (definite common noun), c. ndef (indefinite common noun),
- d. foc (focussed noun to be fronted by syntactic structures like left dislocation, it- cleft, topicalization, etc.),
- e. top (topic noun - to be pronominalized), f. rel (relative pronoun argument),
- g.trace(controller of syntactic or lexical controller), i. pro(empty or lexically unexpressed noun),

Cardinality: : a number/nil; *Number:* : sing(ular)/pl(ural) ; *Head:* : lexical head

Argument specifications 2. Modification

Adjectival Phrase, Prepositional Phrase, Predicative Adjuncts

The following constitutes the input to the Tactical Component for the examples 1 and 2:

Ex.1: Ieri Mario corse a casa / Yesterday Mario ran home

Voice=act,
Tense=past,
Mood=indic,
Modality=assert ,
Main_relation=correre,
Main_relation_modifier=[dtemp,ieri],
List_of_arguments=[
First_argument=[prop, nil, sing, mario],
Second_argument=[meta, casa]
]

Ex.2: Maria che ieri lo cercava lo insultò / Maria who yesterday was looking for him, insulted him

Voice=act,
Tense=past,
Mood=indic,
Modality=assert ,
Main_relation=insultare,
List_of_arguments=[
First_argument=[prop, nil, sing, [maria,
First_argument_modifier=[
Voice=act,
Tense=imperf,
Mood=indic,
Main_relation=cercare,
Main_relation_modifier=[dtemp,ieri],
List_of_arguments=[
First_argument=[rel, nil, sing, maria],
Second_argument=[top, nil, sing, mario]
]
Second_argument=[top, nil, sing, mario]
]

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